Original Article

Evaluation of Postoperative Pain Relief after Pulpotomy using Different Procedures for Disinfection and Hemostasis in Symptomatic Irreversible Pulpitis

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ABSTRACT

Aim: This study aimed to evaluate postoperative pain scores after sodium hypochlorite (NaOCl) and KTP laser pulpotomies in the permanent teeth with symptomatic irreversible pulpitis retrospectively. **Materials and Methods:** This study is based on the records of patients treated with pulpotomy using sodium hypochlorite or KTP laser for disinfection and hemostasis at the Department of Endodontics. Sixty patients' molar teeth were treated with either NaOCl or KTP laser. Sodium hypochlorite was used on 31 teeth, and KTP laser was used on another 29 teeth, for disinfection and hemostasis. Initial bleeding control was obtained with saline. 2.5% NaOCl or KTP laser was applied to complete hemostasis. Calcium hydroxide was then placed on the chamber floor to cover the canal orifices. The permanent restoration was completed with composite resin. Pre and postoperative pain scores were recorded with a visual analog scale. The evaluation was performed on the 6th, 24th, 48th, 72nd hours, and 7th days depending on the severity of the pain. **Results:** There was no significant difference between the groups in terms of demographic data and preoperative pain scores ($P > 0.05$). The postoperative pain score in the KTP laser group was significantly lower at the 24th hour than in the NaOCl group ($P < 0.05$). No significant difference was found between the groups at other evaluated time intervals ($P > 0.05$). The greatest pain score was recorded at the 6th hour in both groups. **Conclusion:** Although the level of pain decreased significantly in both groups in the postoperative period, KTP laser-assisted pulpotomy provided better pain control, especially at the 24th hour.

KEYWORDS: *Irreversible pulpitis, KTP laser, postoperative pain, pulpotomy, visual analog scale*

INTRODUCTION

Permanent teeth with symptomatic irreversible pulpitis are usually treated with root canal therapy.[1] Studies have shown that there is no good correlation between the actual histological state of the pulp and clinical symptoms and diagnostic data.[2,3] In addition, a healthy histological structure may be found within the coronal and root pulp a few millimeters from the inflamed pulp.[4] Root canal treatment also has disadvantages such as being costly and requiring more than one session.[5] If the pulp is removed from the root canals with root canal treatment, the repair potential of the pulp decreases, and the immune defense mechanism of the pulp is lost.[4] It has been reported that teeth with irreversible pulpitis have the potential to heal if pulpal inflammation can be controlled.[4] Thus, a pulpotomy is thought to be an alternative treatment option to root canal treatment in adults.[6] In addition, among the treatment procedures in patients with symptomatic

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irreversible pulpitis, pulpotomy has proven to be more effective in relieving pain.[7]

Pulpotomy is the surgical removal of the coronal pulp tissue to preserve the remaining radicular pulp.[8] It is aimed to induce dentin bridge formation with the dentinogenic potential of pulp cells by using various materials to cover the remaining pulp tissue.[9] Calcium hydroxide is one of these materials.[8] Hess[10] used calcium hydroxide in pulpotomy in 1929. In addition, Stanley[11] strongly recommended the use of calcium hydroxide in vital pulp treatments. Calcium hydroxide is still used today in vital pulp treatments to coat the dental pulp owing to its properties such as inducing dentin bridge formation when applied to the exposed pulp surface.[8,11]

In previous studies,[12,13] the hemostatic and antibacterial effects of different solutions and laser applications in vital pulp treatments (VPT) were investigated. The laser minimizes the risk of bleeding, mechanical damage, or bacterial contamination. Thus, it can be effective in pulpotomy treatments.[12] It has been reported that the KTP laser does not cause pulp or periodontal tissue damage when used at appropriate values.[13] It is thought that the KTP laser plays a role in reducing immediate postoperative pain, shortening the bleeding control period, and providing good hemostasis.[14] Sodium hypochlorite (NaOCl) is one of the solutions recommended to be used in vital pulp treatments due to its hemostatic and antibacterial effects.[15] It has been reported that NaOCl is biologically compatible with pulp tissues and gives successful results when used as a hemostatic agent in vital pulp treatments.[15]

This study evaluated the effects of the use of sodium hypochlorite and KTP laser for disinfection and hemostasis on postoperative pain in pulpotomy of permanent teeth with symptomatic irreversible pulpitis.

Methodology

Study design and data collection

This study is based on records of patients with various permanent molars diagnosed with symptomatic irreversible pulpitis treated by pulpotomy using NaOCl or KTP laser at the Department of Endodontics between 2020-2021. This study was conducted from data obtained for clinical purposes and following the Declaration of Helsinki. Ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Sivas Cumhuriyet University (ethics committee code: 2021-10/07). All treatment procedures were part of routine care, in which patients were verbally informed.

Study population

The clinical records of 60 patients who met the inclusion criteria were analyzed. Analyzed data included age, gender, presence of a percussion, tooth arch, electric pulp test, hemostasis time, presence of a periapical lesion, analgesic consumption postoperatively, and preoperative and postoperative pain scores.

Patients treated with pulpotomy using KTP laser and NaOCl were selected according to the following inclusion criteria: individuals should be at least 18 years of age at the time of pulpotomy, patients without any systemic disease, a single tooth in every patient, should be signs of irreversible pulpitis (lingering/spontaneous pain and/or is exacerbated by the cold, prolonged response to cold testing) with/without symptomatic apical periodontitis, teeth responded positively to electrical and thermal stimuli, the tooth is restorable, probing pocket depth (3 mm), and mobility are within normal limits, treatments should be performed and followed up by the same operator.

Exclusion criteria were the following: the presence of allergies, using analgesics in the last 12 hours or antibiotics in the last 1 week before the procedure.

Records of 31 patients treated with NaOCl and 29 patients treated with KTP laser were analyzed. The application of the agents was randomly chosen for the teeth.

Treatment protocol

Local anesthesia was obtained with articaine (Maxicaine Fort®, VEM, Turkey). The tooth crown was disinfected with 5% NaOCl after rubber-dam isolation. The cavity was prepared by the principles of the cavity. Necrotic and infected dentin was removed using an excavator and/or a round bur in a low-speed handpiece. The cavity was cleaned with a cotton pellet soaked in 5% NaOCl and then the pulp chamber was unroofed with a sterile bur. Coronal pulp tissue was removed with a sterile round bur on a water-cooled high-speed handpiece. Initial hemorrhage was controlled using a cotton pellet soaked with physiological saline. Complete hemostasis and cavity disinfection were obtained by the application of 2.5% NaOCl or KTP laser according to the groups.

Group 1: Hemostasis and cavity disinfection with NaOCl (n = 31)

In this group, hemostasis was achieved by checking the cotton pellet soaked with 2.5% NaOCl placed in the pulp chamber at 2-minute intervals until 6 minutes, and the duration of hemostasis was recorded. The NaOCl also acted as the cavity disinfectant.

Group 2: Hemostasis and cavity disinfection with KTP laser (n = 29)

In this group, complete hemostasis and cavity disinfection was achieved by applying a KTP laser (SMARLITE D, Deka, Calenzano FI, Italy) with 532 nm wavelength, (1.5 W, pulse and non-contact mode, Ton 100 ms, Toff 100 ms) for 2 seconds. The diameter of the optical fiber was 300 μm. Laser application was repeated if necessary as many as three times. After the bleeding control was achieved, cavity disinfection was performed by laser application (1 W, 300 μm tip, circular motion, and non-contact mode) for 5 seconds.

Calcium hydroxide was then placed against the pulp orifices and the pulp chamber floor. Glass-ionomer cement (Kavitan Plus, Pentron, Spofa Dental, Czech Republic) was placed over the calcium hydroxide. Permanent restoration of the tooth with composite resin (3M-ESPE, St. Paul, MN, USA) was performed in the same session. Patients were prescribed 400 mg ibuprofen/500 mg acetaminophen (every 6 hours for the first 24 hours) for severe postoperative pain.

Assessment of pain

The patient received a form to assess preoperative and postoperative pain. Patients recorded postoperative pain levels at the 6th, 24th, 48th, and 72nd hour and 7th day time intervals on a 100 mm visual analog pain scale (VAS) (0 mm marking no pain and 100 mm marking maximum pain) depending on the severity of the pain.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (IBM SPSS 22.0) Software. The Kolmogorov-Smirnov test was used to assess the normality of the data. The data were analyzed statistically using the Mann-Whitney U, Friedman, and Chi-square test at a significance level of $P < 0.05$.

Results

Table 1 shows analyses of demographic and clinical data. There was no statistical difference between the two groups in terms of age, gender, percussion test, preoperative electric pulp test, periapical status (radiographic), duration of hemostasis, location of the tooth, or postoperative analgesic consumption ($P > 0.05$). The KTP laser group had a statistically lower pain score than the NaOCl group at the 24th hour ($P < 0.05$; Table 2, Figure 1). Although no significant difference was observed between the groups in the other postoperative periods, the KTP laser had lower pain scores ($P > 0.05$).

In both groups, the preoperative pain score was significantly higher than the pain scores at all postoperative time intervals evaluated (P <0.05; Table 2, Figure 1). In the NaOCl group, the 6th-hour pain score was significantly higher than pain scores at all other postoperative time intervals ($P < 0.05$). In the KTP laser group, the pain score at the 6th hour was significantly higher than the pain scores at the 72nd hour and 7th day ($P < 0.05$).

Table 1: Demographic data and Pre-/ıntra-/postoperative factors/conditions for the NaOCl and KTP laser groups

	NaOCl (*n*=31)	KTP Laser (*n*=29)	*P*
Demographics data			
Age (years±SD)	25.74±7.09	26.75±8.00	0.311
Gender, *n* (%)			
Male	18 (58.1%)	19 (65.5%)	0.553
Female	13 (41.9%)	10 (34.5%)	
Pre and intraoperative factors			
Percussion test, *n* (%)			
Positive response	28 (90.3%)	27 (93.1%)	0.697
Negative response	3 (9.7%)	2 (6.9%)	
Preoperative electric pulp test, (mean±SD)	27.61±15.80	30.31±19.90	0.380
Periapical status/radiographic, *n* (%)			
Normal	21 (67.7%)	19 (65.5%)	0.855
Radiolucency or widening of PDL	10 (32.3%)	10 (34.5%)	
Duration of hemostasis (mean±SD)	3.48±1.17	2.72±1.13	0.882
Location of the tooth *n* (%)			
Maxillar	11 (35.5%)	6 (20.7%)	0.204
Mandibular	20 (64.5%)	23 (79.3%)	
Postoperative analgesic usage			
Yes	4 (12.9%)	5 (17.2%)	0.638
No	27 (87.1)	24 (82.8)	

P<0.05. PDL, periodontal ligament; SD, standard deviation

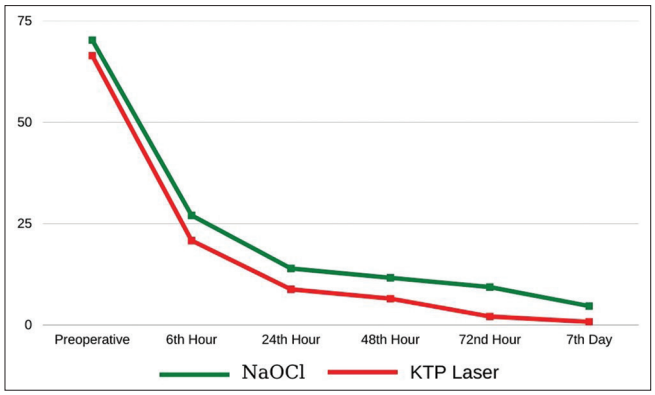

Figure 1: Changes in the pain rating scores according to the treatment groups

Discussion

Endodontic treatment is associated with more frequent and severe postoperative pain in dental procedures.[16] As root canal treatment takes a long time, the anesthetic effect decreases, which may be effective in the sensation of pain.[17] Galani *et al*.[1] compared postoperative pain and success rates after pulpotomy and root canal treatment. According to study results, lower postoperative pain and discomfort were reported for the pulpotomy group. In addition, it has been reported that pulpotomy treatment almost halves the treatment time compared to root canal treatment.[18] The patient can feel more comfortable during the treatment as the pulpotomy procedure takes less time. This study retrospectively evaluated the clinical effects of NaOCl and KTP laser, which are used for hemostatic and disinfection effects during pulpotomy treatment of permanent teeth with symptomatic irreversible pulpitis, on postoperative pain. There are a limited number of studies in the literature evaluating post pulpotomy pain in permanent teeth.[1,18]

The diagnostic terminology of reversible and irreversible pulpitis is debated by researchers today. The diagnosis of irreversible pulpitis is based on clinical diagnostic procedures and not histological findings. These clinical diagnostic procedures are unreliable.[4] Ricucci *et al*.[19] evaluated the reliability of clinical diagnosis of reversible and irreversible pulpitis relative to histological diagnosis. According to study results, the consistency between clinical and histological findings of irreversible pulpitis was 84.4%. In addition, studies have reported that when the inflamed pulp is removed, the remaining healthy pulp can be saved with a high success rate.[20,21] The wound healing process is a pathological process that works in the same general principle in the pulp as in other organs of the body.[4] Based on these studies, the data of patients with irreversible pulpitis were included and analyzed. In the present study, it was observed that the pain values in the 1st week decreased significantly compared to the preoperative level.

Table 2: Comparison of pain rating scores measurements between groups

	NaOCl (*n*=31) Mean±SD	KTP Laser (*n*=29) Mean±SD	*P*
Preoperative pain	70.29±14.05	66.44±9.29	0.297
Postoperative 6th hour	27.06±21.82	20.86±26.34	0.073
Postoperative 24th hour	13.96±18.15	8.82±21.86	0.005*
Postoperative 48th hour	11.67±21.17	6.55±19.01	0.120
Postoperative 72nd hour	9.38±19.02	2.13±5.66	0.216
Postoperative 7th day	4.7±14.14	0.82±2.25	0.216

*P<0.05 indicates significant difference

One of the most favorable pulp-capping agents is calcium hydroxide. Calcium hydroxide has a high pH value and thus stimulates fibroblasts and enzyme systems, neutralizes the low pH of acids, shows antibacterial properties, and supports pulp defense and repair.[22] The main reason for using calcium hydroxide as a pulp-capping agent is its antibacterial properties.[23] Calcium hydroxide is an ideal pulp protectant and biocompatible agent. However, it has a very low compressive strength.[22] Inflammation and necrosis on the pulp surface, toxic effects on cells, tunnel defects in newly-formed tertiary dentin bridges, and dissolution under permanent restorations are undesirable features of calcium hydroxide.[24] Many studies[25,26] have reported that MTA is superior to calcium hydroxide as a pulp-capping agent. However, MTA has disadvantages such as difficultly to handle, long setting time, and high cost. In some studies,[27,28] calcium hydroxide and MTA were compared in terms of pain and long-term success. While MTA was found to be superior in a previous study,[28] it was stated that there was no difference between MTA and calcium hydroxide in another previous study.[27] Calcium hydroxide was used as a pulp-capping agent in the current studies.[27,28]

NaOCl was used as a hemostatic agent in the present study as in many other studies.[1,28] Hafez *et al*.[15] emphasized that bleeding control with NaOCl is as important as hermetic closure. Besides excellent hemostasis ability, NaOCl has antibacterial properties, disinfects contaminated dentin adjacent to the exposure site, and prevents fibrin formation.[28] NaOCl has been associated with neurological damage after prolonged exposure to the alveolar bone from the root canal.[29] The application of NaOCl to the pulp surface may contribute to the reduction of pain by affecting the neurogenic sensors. Ballal *et al*.[30] evaluated the effects of washing the pulpal wound with a 2.5% NaOCl or physiological saline in pulp-exposed to asymptomatic teeth with deep caries. NaOCl solution has been reported to cause a remarkably significant reduction in postoperative

discomfort and early painful failures compared to physiological saline. In the present study, although NaOCl was associated with higher pain scores in all periods compared to KTP laser, it was significant only at the 24th hour time interval.

Surgical use of laser is increasing day by day owing to its features such as rapid hemostasis, reducing the risk of contamination, providing a sterile surgical area, and reducing the level of edema and pain in the postoperative period.[31] The KTP laser is a frequency-doubled Nd: YAG laser with a wavelength of 532 nm, which can be selectively absorbed by oxyhemoglobin. Liu[32] evaluated the effects of Nd: YAG laser pulpotomy and formocresol pulpotomy on human primary teeth and stated that the success rate of Nd: YAG laser pulpotomy was significantly higher than formocresol pulpotomy. Fornaini *et al.*[33] evaluated low-power (1 W - CW) laser-assisted KTP laser surgery in terms of intervention characteristics and patient compliance. They reported that the low-power KTP laser has been reported to provide good pain control and recovery. Auf *et al*.[14] compared KTP laser tonsillectomy (12-14 W, cutting mode) with standard tonsillectomy surgery. It was reported that blood loss was less in the KTP laser group and although there was less pain at the beginning (up to day 1), the wound was more painful in the long term due to delayed healing. In the present study, the mean pain scores of the KTP laser group were lower in all time intervals. Photochemical effects responsible for biostimulation and inhibition of pain stimuli occur at low power density.[33] This may explain the success of the low-power KTP laser in postoperative pain control. It has been reported that using the KTP laser at high power may cause secondary infections through its photothermal effects such as evaporation, carbonization, burning, coagulation, and hyperthermia in the tissues. Secondary infections may cause delayed wound healing and pain.[33] Additionally, the placebo effect of laser may contribute to postoperative pain reduction. This effect consists of a complex mix of physiological and psychological interactions.[34]

The perception of pain is a highly subjective and variable experience that is modulated by physical and psychological factors.[35] Accurate and reliable assessment of pain plays a crucial role in pain research and effective pain management.[35] Pain scales including the VAS have been used in many studies[35,36] to assess pain severity. The VAS is a valid and reliable scale for the measurement of human pain intensity and discomfort when properly designed and applied.[37]

Data from this study revealed that mean pain scores decreased over time in the post-pulpotomy periods. These findings are consistent with findings from other clinical studies[1,30] showing a significant reduction in pain after pulpotomy treatment. Results from these studies highlight the effectiveness of pulpotomy in pain relief. Cutting the terminal ends of nociceptive sensory neurons, the reduction in local tissue pressure and inflammatory mediator concentrations in pulpotomy treatment may affect the postoperative pain intensity.

Polycarpou *et al*.[38] evaluated the risk factors associated with pain after root canal treatment and reported that factors such as preoperative pain level, presence of percussion, and gender may affect postoperative pain. However, there was no difference between the groups in terms of demographic data in the present study.

Limitations

The retrospective nature of this study and the small sample size were also limitations of this study. Blinding could not be done because a laser was used in the study. The lack of information about the marital status, education, and socio-cultural levels of the patients is one of the limitations of the study. Therefore, further clinical trials with larger sample sizes are needed to demonstrate the efficacy of laser irradiation and evaluate the clinical outcomes of different laser wavelengths used for pulpotomy in medicine.

Conclusion

Postoperative pain score was lower in the KTP laser group compared to the NaOCl group. KTP laser-assisted pulpotomy provided more effective pain relief in patients with symptomatic irreversible pulpitis.

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Conflicts of interest

There are no conflicts of interest.

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